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PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53 (c).

Express Mail Label No. EV312069701 Date of Deposit: OCTOBER 6, 2003

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
YINGWEI	CHEN	BRIARCLIFF MANOR, NEW YORK
DAGNACHEW	BIRRU	YORKTOWN HEIGHTS, NEW YORK
JAMES	WENDORF	CORTLANDT MANOR, NEW YORK

☐ *Additional inventors are being named on the _____ separately numbered sheets attached hereto*

TITLE OF THE INVENTION (280 characters max)

DIGITAL TV TRANSMISSION AND RECEIVING SYSTEM WITH SEPARATE ROBUST CHANNEL TO AID STANDARD RECEPTION

CORRESPONDENCE ADDRESS

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☒ Specification *Number of Pages* 5 ☐ CD(s), Number

☒ Drawing(s) *Number of Sheets* 0 ☐ Other (specify)

☐ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT *(check one)*

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check or money order is enclosed to cover the filing fees

FILING FEE AMOUNT ($)

☒ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 14-1270 160.00

☐ Payment by credit card. Form PTO-2038 is attached.

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: _____.

Respectfully submitted,

SIGNATURE _____ Date OCTOBER 6, 2003

TYPED or PRINTED NAME MICHAEL E. BELK REGISTRATION NO.: 33,357 *(if appropriate)*

TELEPHONE (914) 333-9643 Docket Number: US030399

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

YINGWEI CHEN ET AL

Atty. Docket

US030399

Serial No.

Filed: CONCURRENTLY

Title: DIGITAL TV TRANSMISSION AND RECEIVING SYSTEM WITH SEPARATE ROBUST CHANNEL TO AID STANDARD RECEPTION

Commissioner for Patents
Alexandria, VA 22313

AUTHORIZATION PURSUANT TO 37 CFR §1.136(a)(3)
AND TO CHARGE DEPOSIT ACCOUNT

Sir:

The Commissioner is hereby requested and authorized to treat any concurrent or future reply in this application requiring a petition for extension of time for its timely submission, as incorporating a petition for extension of time for the appropriate length of time.

Please charge any additional fees which may now or in the future be required in this application, including extension of time fees, but excluding the issue fee unless explicitly requested to do so, and credit any overpayment, to Deposit Account No. 14-1270.

Respectfully submitted,

By Michael Belk
Michael E. Belk, Reg. 33,357
Attorney
(914) 333-9643

Title: Digital TV Transmission and Receiving System with S parate Robust Channel to Aid Standard Reception

Background

Current digital TV transmission (such as ATSC or DVB) involves sending a TV program through a single channel. However, because the single channel often doesn't provide robust enough reception under certain circumstances, a separate robust mode is being developed to provide better reception. This invention pertains to carrying TV program-related data in the robust mode, to improve the quality of the standard TV program reception.

One obvious option is to transmit FEC (forward error correction) codes in the robust mode to enable or expand error correction of the standard video stream. Another option is simply carrying a lower quality version of the standard video stream.

Separately, the concept of unequal error protection or prioritised video transmission has been widely documented in literature, though still remains to be deployed in real systems. There, one transmission channel is carved timewise into different portions of different robustness or packet error characteristics. The video signal is encoded into several layers that when received, contribute different amounts to the final video quality. The video layers of different importance are then transmitted through the different portions of the channel with different robustness. This leads to more efficient usage of the medium, thus better video quality.

Those skilled in the art are directed to the following citations which are hereby incorporated in whole by reference.

"PES packets and elementary streams" in "Comprehensive MPEG2 Video Compression Tutorial" by Wayne E. Bretl and Mark Fimoff, January 15, 2000, at www.bretl.com

ATSC Standard A/53: Digital Television Standard, August 2001, at http://www.atsc.org

Advancement of State of the Art

In the invention, a video transmission and receiving system selects the most important portions of the standard video stream and provides a robust mode (channel) that carries FEC for those selected portions. Compared with the other usages of the robust channel, the disclosed system utilizes the robust mode bandwidth more efficiently by recognizing which part of the standard video stream is most important and hence should be better protected.

Descriptions

The standard video stream is usually divided into packets for transmission. For example, in the ATSC DTV transmission standard, an MPEG-2 video transport stream is divided into PES (packetized elementary stream) packets, and each PES packet is then combined with the corresponding error correction (parity) bits to form a transmission packet, to be transmitted through the "standard mode". Below we first describe the generic method for selectively applying error correction coding, carried in the robust mode, to video data carried in the standard mode. We then present two particular instances for the generic framework.

Generic Method

First, video transmission frames (PES packets plus FEC) are divided into groups for the purpose of selective FEC application. The particular selection of the group size depends on tradeoffs

among delay, buffering required, and bandwidth efficiency. For example, a larger group size introduces a larger additional end-to-end delay, requires a larger buffer to hold the frames, but results in more flexibility in selective FEC application which in turn leads to higher bandwidth efficiency.

The grouping of transmission frames is illustrated in Figure 1. Sequential transmission frames each consists of a PED packet followed by FEC data for the transmittal frame.

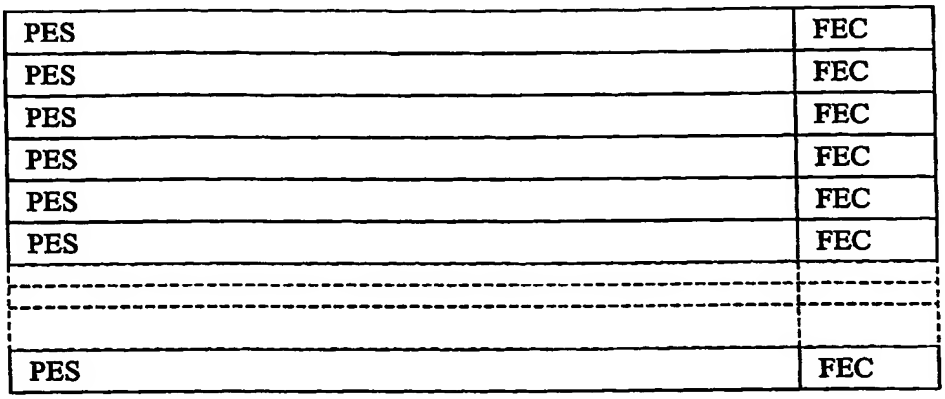

Figure 1. Grouping of transmission frames (PES+FEC)

Second, selective FEC is then applied to each group of PES packets. This involves

- Selecting PES data to apply additional FEC (to be carried in robust mode). The selection can be at the PES packet level or at the PES segment level. In the latter case, each PES packet is further divided into segments of a certain number of bytes, e.g., 32 bytes (for a PES packet size of 188 bytes, the sixth segment will have only 28 bytes).
- Encoding the bit map that signifies which PES packet or segment is selected, to be carried in the robust mode. The robust mode frame will have the following format:

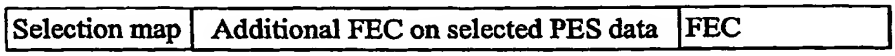

Figure 2. Robust mode frame format

The robust portion is a series of one or more robust mode frames, each robust mode frame includes a robust data portion followed by FEC data for the frame. The robust data portions consist of a selection map followed by additional FEC data for selected PES segments. The selection map may occupy sections of one or more robust data portions and the additional FEC data which also may occupy sections of one or more robust data portions. In one embodiment each robust data portions includes a portion of the selection map followed by a portion of the additional FEC data. In another embodiment, all the portions of the selection map are followed by the portions of the additional FEC data.

- Applying additional (stronger) FEC to collections of selected PES data and carrying resulting FEC codes in the robust mode. Note that the scanning of the selected PES segments/packets can either be row (PES packet) based or column-based. The latter effectively results in "transverse" application of FEC on the selected data, compared with the original standard mode FEC that is applied to PES data.

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PES	FEC
PES	FEC
PES	FEC
PES	FEC
PES	FEC
PES	FEC
PES	FEC

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- Encoding the bit map that signifies which PES packet or segment is selected, to be carried in the robust mode. The robust mode frame will have the following format:

Selection map	Additional FEC on selected PES data	FEC

Figure 2. Robust mode frame format

The robust portion is a series of one or more robust mode frames, each robust mode frame includes a robust data portion followed by FEC data for the frame. The robust data portions consist of a selection map followed by additional FEC data for selected PES segments. The selection map may occupy sections of one or more robust data portions and the additional FEC data which also may occupy sections of one or more robust data portions. In one embodiment each robust data portions includes a portion of the selection map followed by a portion of the additional FEC data. In another embodiment, all the portions of the selection map are followed by the portions of the additional FEC data.

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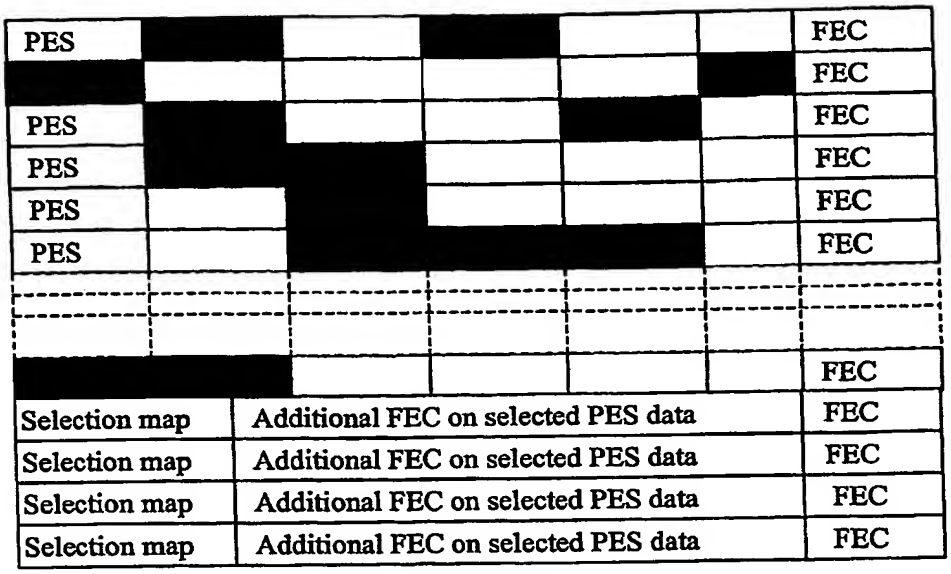

Figure 3(a). Group of standard mode frames (PES+FEC) and corresponding robust mode frames containing segmented selection map

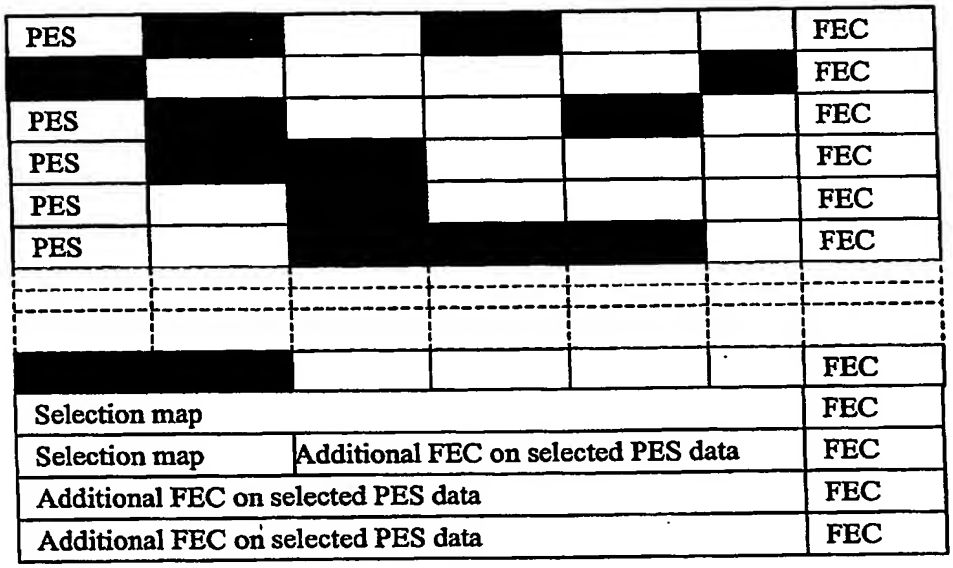

Figure 3(b). Group of standard mode frames (PES+FEC) and corresponding robust mode frames where the whole selection map for a group of packets is transmitted first followed with the additional FEC

In figures 3(a) and 3(b) dark segments indicate the segments of the PES packets that are selected for additional FEC . In figure 3(b) the selection map occupies sequential sections of the robust data portions and the additional FEC data follows all the selection map. In figure 3(a) sections of the selection map and sections of the additional FEC data are interleaved.

PES packet based selective FEC

In the first implementation, the robust mode FEC is applied on a subset of the PES packets. The selection of the PES packets is performed as follows:

1. If the PES packet contains audio information, it is selected. The packet ID (PID) field in the PES packet conveys this.
2. If the PES packet doesn't contain audio but video header information (frame header, slice header, macroblock header, or block header), it is selected. This is done by parsing the packet.
3. A certain number of subsequent video PES packets (n) (up to the next video PES packet containing header information) are also selected. n depends on the bit rate of the standard mode video bit stream as well as the portion (p) of it that the robust mode FEC needs to protect. It can be dynamically adjusted as follows:
    a. The number is initialised to a pre-determined number, e.g., 0.
    b. The number of PES packets between two consecutive PES packets containing some header information (frame, slice, mb, or block) is counted (N).
    c. n is determined as pxN, and can be updated periodically.
    d. n can not exceed n_{max}, the number of standard mode frames in a group.

The robust mode Selection Map indicates which PES packets are to have the robust mode FEC applied to them.

On the receiver end:

1. The group of standard mode PES packets and the associated robust mode packets are obtained.
2. The Selection Map is decoded from the robust mode to track which PES packets the robust mode FEC data corresponds to.
3. If there are unrecoverable errors in a decoded standard mode PES packet that has corresponding robust mode FEC data, FEC decoding is performed on the PES packet. Video decoding proceeds with the correctly decoded PES packet.
4. If corresponding robust mode FEC data is not available, an erred PES packet is discarded.

PES segment based selective FEC

In the second implementation, the robust mode FEC is applied to a subset of bits in each PES packet. The selection of such subset in PES packets is carried out as follows:

1. The PES header is selected if the PES packet contains at least one selected segment.
2. The PES packet payload (excluding the PES header) is divided into M segments, each containing m bytes.
3. All PES segments in an audio PES packet are selected.
4. For video PES packets, if a segment contains header information, it is selected.
5. n subsequent segments are also selected, until the next segment with header information. n is adjusted dynamically such that the overall robust mode FEC bit rate is satisfied, and delay between robust mode FEC packets and the standard mode PES packets is kept below a threshold.
6. A field indicating whether each of the M PES segment is selected is carried in the robust mode Selection Map.

On the receiver end:

1. Both standard mode and robust mode packets are obtained.
2. The Selection Map in the robust mode is used to obtain the map of PES segments to which the robust mode FEC is applied.
3. If any of the corresponding PES packet contains irrecoverable errors from standard mode decoding, additional FEC decoding is performed to correct the selected PES segments.
4. The corrected PES packets are decoded.

Applicability

DTV receivers supporting robust mode.

Abstract

A video transmission and receiving system selects the most important portions of the standard video stream and provides a robust mode (channel) that carries FEC for those selected portions.

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YINGWEI CHEN ET AL

Atty. Docket

US030399

Serial No.

Filed: CONCURRENTLY

Title: DIGITAL TV TRANSMISSION AND RECEIVING SYSTEM WITH SEPARATE ROBUST CHANNEL TO AID STANDARD RECEPTION

Commissioner for Patents
Alexandria, VA 22313

APPOINTMENT OF ASSOCIATES

Sir:

The undersigned Attorney of Record hereby revokes all prior appointments (if any) of Associate Attorney(s) or Agent(s) in the above-captioned case and appoints:

MICHAEL E. BELK **(Registration No. 33,357)** c/o U.S. PHILIPS CORPORATION, Intellectual Property Department, 580 White Plains Road, Tarrytown, New York 10591, his Associate Attorney(s)/Agent(s) with all the usual powers to prosecute the above-identified application and any division or continuation thereof, to make alterations and amendments therein, and to transact all business in the Patent and Trademark Office connected therewith.

ALL CORRESPONDENCE CONCERNING THIS APPLICATION AND THE LETTERS PATENT WHEN GRANTED SHOULD BE ADDRESSED TO THE UNDERSIGNED ATTORNEY OF RECORD.

Respectfully,

Michael E. Marion, Reg. 32,266
Attorney of Record

Dated at Tarrytown, New York
this 6th day of October, 2003.